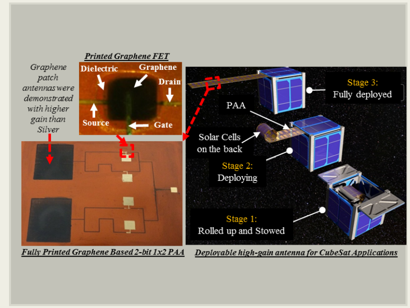
Fully Printed Flexible 4-bit 2D (4x4) 16-Element Graphene-Based Phased Array Antenna System, Phase II

Completed Technology Project (2015 - 2017)

Project Introduction

Communication technologies support all NASA space missions, among which autonomous communication technologies are extremely beneficial to future missions, including the Asteroid Redirect Mission, and human expedition to Mars and beyond. Low-cost, high gain, light-weight, and flexible active antenna systems are highly desired. In this program, we propose to develop a fully flexible ink-jet printed monolithic graphene-based high frequency PAA communication system. The superior electronic, optical, mechanical, and thermal properties offered by graphene (carrier mobility ~ 200,000cm^2/V.s; optical transparency ~ 98%; high current density ~ 10^8A/cm^2; thermal conductivity ~ 5000W/mK) is expected to significantly enhance the system features compared to the state-of-the-art flexible antenna systems., with operating frequency in excess of 100GHz expected. In Phase I, we printed graphene field-effect transistors and demonstrated a high (38:1) On/Off ratio. Graphene patch antennas were demonstrated with higher gain than silver. Results also indicated the feasibility of reducing the antenna size for a given frequency without sacrificing the gain. Finally, a 2-bit 1x2 graphene PAA was fully printed, and beam steering of a 4GHz RF signal from 0 to 42.4 degrees was demonstrated. The antenna system also showed good stability and tolerance after 5500 bending cycles. In Phase II, the graphene material inks will be further optimized for achieving high performance FETs and conductive films. A fully packaged 4-bit 2D 4x4 S-band PAA on a flexible substrate will be developed, and performance features, including gain/efficiency, frequency range, bandwidth, power consumption, and lifetime/reliability, will be characterized. Additionally, a roll-to-roll process to scale-up production will be developed, and the feasibility of large antenna array manufacturing at low-cost will be demonstrated.



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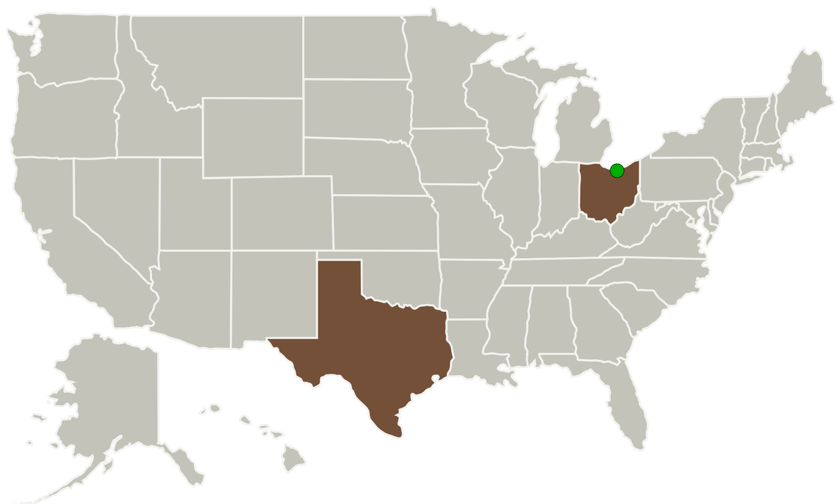
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Omega Optics, Inc.	Lead Organization	Industry	Austin, Texas
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio
Texas State University	Supporting Organization	Academia Hispanic Serving Institutions (HSI)	San Marcos, Texas

Primary U.S. Work Locations	
Ohio	Texas

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Omega Optics, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

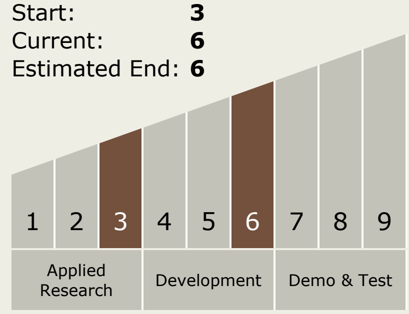
Carlos Torrez

Principal Investigator:

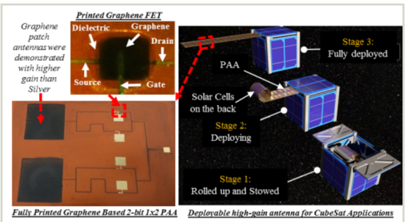
Xiaochuan Xu

Technology Maturity (TRL)

Start: **3**
Current: **6**
Estimated End: **6**



Images



Briefing Chart Image
Fully Printed Flexible 4-bit 2D (4x4) 16-Element Graphene-Based Phased Array Antenna System, Phase II
(https://techport.nasa.gov/image/137024)

Technology Areas

Primary:

- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
  └ TX05.2 Radio Frequency
    └ TX05.2.6 Innovative Antennas

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System